Dipole Directed Self Assembly of Ni-Coated Au-Nanorods

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Experimental

Preparation of gold nanorods: An Au stock solution (0.1M $HAuCl_4$) was used for the preparation of seeds. To 10 ml of 0.1M CTAB, 25 µl of Au stock solution was added. While stirring, 60 µl of ice cold $NaBH_4$ was added, and stirring continued for 2 min. The solution turned light brown right after addition of $NaBH_4$, indicating particle formation.

150 ml of 0.1M CTAB was mixed with 750 µl Au stock solution. After this, 150 µl of 0.1 M $AgNO_3$ was added, followed by the addition of 1050 µl of 0.1M ascorbic acid, and the growth solution quickly turned from dark yellow to clear and colourless. To this colourless growth solution 210 µl of CTAB-capped seeds were added and the resulting solution was left overnight at 25 ºC. Figure S1 shows a TEM image and the histogram of the aspect ratio distribution.

Platinum coating: For Pt coating of Au nanorods, we started with 10 mL of aspect ratio 3 nanorods, added to 20 mL of 0.1 M CTAB, followed by addition of 110 µl of 0.04 M K_2PtCl_4 solution. The solution was left for half an hour at 40 °C for complexation of platinum with CTAB. Then, 940 µl of 0.1 M ascorbic acid was added and the solution was left overnight at 40 °C. The next day, the solution was centrifuged twice at 1000 rpm for 10 minutes, and the precipitates were redispersed in an equal volume of 0.1 M CTAB solution. The slight red shift in UV-Vis spectra confirmed Pt-coating on the rod surface.

Nickel Coating: The Pt-coated nanorods were further coated with Ni, using hydrazine as a reducing agent. Briefly, in 2.5 ml of Pt-coated nanorods 22.7 ml of clean water (Millipore; 18.2MΩcm) was added, followed by addition of 14, 28 and 56 µl of 0.25 M $NiCl_2$, corresponding to solutions Ni1, Ni2 and Ni3, respectively. This was followed by addition of 50, 100 and 200 µl of 2.72 M hydrazine solution for Ni1, Ni2 and Ni3 solutions, respectively. The solution was kept at 40 °C for three hours. Afterwards, the Ni coated nanorods were separated by centrifugation. The successful coating with Ni was confirmed by UV-Vis spectroscopy of solutions; the characteristic absorption peaks of Au nanorods are no longer visible, indicating the successful coating of Au nanorods with Ni. Furthermore, TEM and EDX analysis also confirmed the Ni-coating, as evident from Fig. S2. The TEM image in Figure S2 shows a darker higher-atomic number Au-core and a lighter lower-atomic number Ni-skin. EDX analysis of darker region confirms the presence of Au, Pt and Ni, whereas the EDX results of lighter region only reveal Ni peaks. The C- and Cu-peaks in both EDX spectra are from the TEM grid.

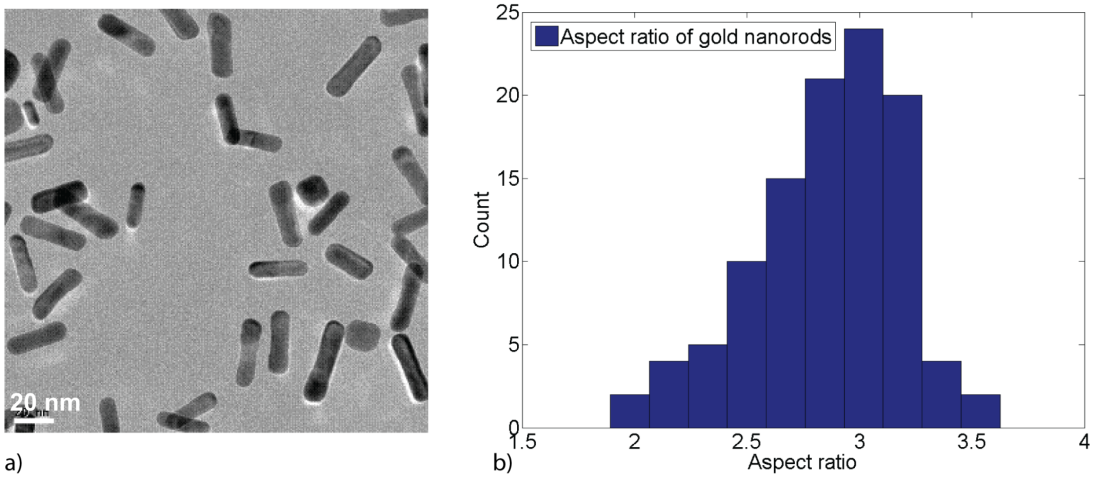

Figure S1. As-prepared Au nanorods used in this work (a) and histogram of their aspect ratio (b).

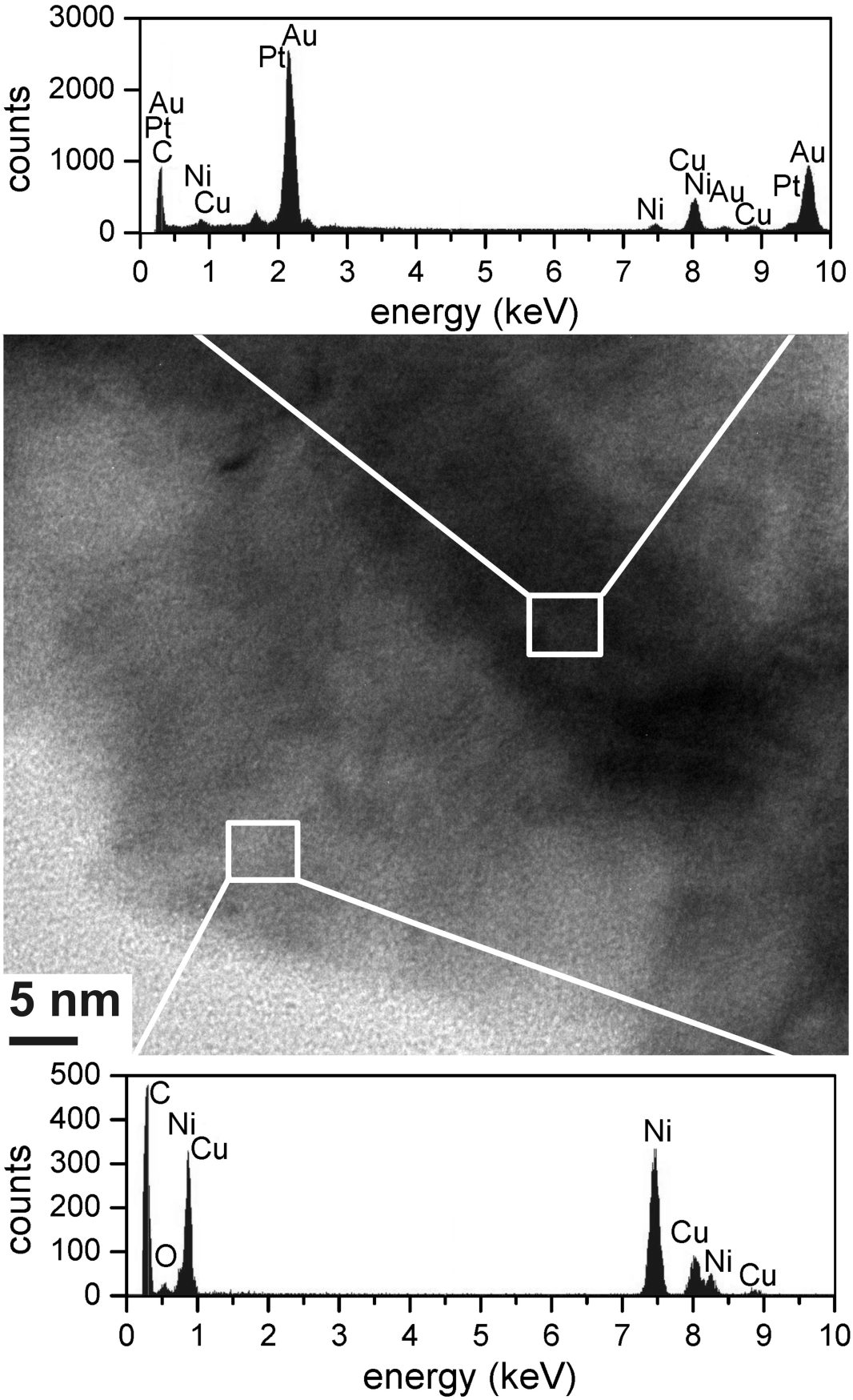

Figure S2. Energy dispersive X-ray (EDX) analysis of Ni-coated Au nanorods.

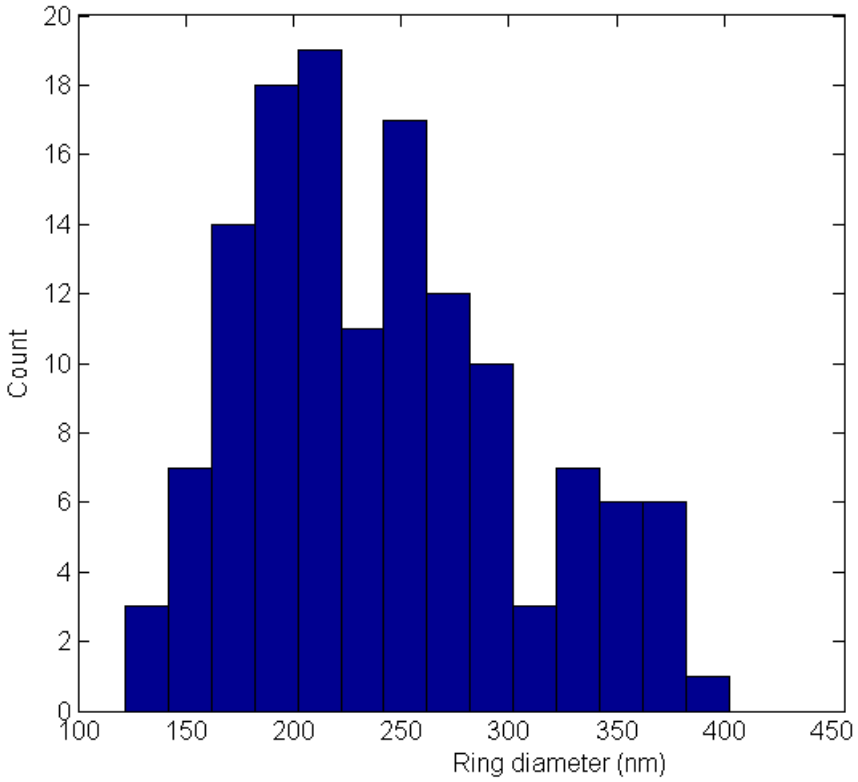

Figure S3. Histogram of inner diameter of nanorings grown using solution Ni3.